Weed communities in three cropping systems suitable for the Midwestern USA were studied from 2017 through 2020 to examine how crop diversification and the intensity of herbicide use affected weed community diversity, stand density, and aboveground mass. A baseline 2-year cropping system with corn (*Zea mays* L.) and soybean (*Glycine max* (L.) Merr.) grown in alternate years was diversified with cool-season crops, namely oat (*Avena sativa* L.), red clover (*Trifolium pratense* L.), and alfalfa (*Medicago sativa* L.) in 3-year and 4-year systems. Herbicide was not applied in the cool-season crops. This study was pursued to address the current gaps of information concerning how the densities and biomass of various weed species respond to the filtering effects of different crop and weed management programs (Fried et al., 2012; Ryan et al., 2010).

Changing the weed management regime from broadcast to banded application and interrow cultivation in corn and omitting herbicides in cool-season crops of the 3-year and 4-year rotations resulted in an overall reduction of in the mass of herbicide active ingredients applied. The reduction in the mass of herbicide active ingredients was associated with increases in weed stand density, aboveground mass, and community diversity. In the cool-season crop phases (oat, red clover, and alfalfa) of the 3-year and 4-year rotations, weed emergence increased, but weed growth did not increase, as compared with the warm-season crop (corn and soybean) environments. Increased weed abundance (Figure 1) under the lower-herbicide regime (Table 1) was not associated with crop yield loss (Figure 2).

Chart

Description automatically generated

Figure 1: Weed abundance in three cropping systems. The abbreviations on the x-axis are crop identities, which are the combinations of the first letter in crop species names and the rotation in which it occurred (C2 - corn in the 2-year rotation, C3 - corn in the 3-year rotation, C4 - corn in the 4-year rotation, S2 - soybean in the 2-year rotation, S3 - soybean in the 3-year rotation, S4 - soybean in the 4-year rotation, O3 - oat in the 3-year rotation, O4 - oat in the 4-year rotation, and A4 - alfalfa in the 4-year rotation).

Table 1: Changes in the mass of herbicide active ingredients applied in more diverse cropping systems as compared to a conventional 2-year corn and soybean system averaged from 2017 through 2020

|  |  |  |  |
| --- | --- | --- | --- |
|  | 2-year | 3-year | 4-year |
| Conventional weed management | -0% | -33% | -50% |
| Low herbicide weed management | -13% | -42% | -57% |

Chart, bar chart, box and whisker chart

Description automatically generated

Figure 2: Mean crop yields by rotation from 2017 to 2020. The color-coded bars show the experimental plots' crop yields (Mg/ha). The error bars show the 95% confidence intervals. The solid horizontal lines show mean yields for Iowa, and dashed lines show mean yields for Boone County. Corn, soybean, and alfalfa yields in the experiment were averaged over four years, oat grain yields in the experiment were averaged over 2017, 2019, and 2020 because, in 2018, oat was harvested for hay. Boone County and Iowa hay yields were averaged over 2017 and 2018 because 2019 and 2020 yields were not available at this writing.

The dominance of aggressive weed species such as common waterhemp (*Amaranthus tuberculatus* (Moq ex DC) J.D. Sauer) and common lambsquarter (*Chenopodium album* L.) tended to be greater in corn and soybean phases of the rotations than in oat, red clover, and alfalfa.

Weed seedbank density could be used as a sustainability indicator (Storkey and Neve, 2018; Liebman et al., 2021). By monitoring aboveground weed communities, a track record of species aggressiveness and collective response to management is available, and thus, it could be easier to control risks of weed resurgence and outbreak. Coupling knowledge of aboveground weed communities with that of weed seedbank composition and abundance would further improve our ability to predict and manage weed communities (Davis et al., 2005; Forcella et al., 1992; Forcella, 2003; Menalled et al., 2001).

The corresponding publication can be found at: <https://www.frontiersin.org/articles/10.3389/fagro.2022.848548>

The data can be found at: <<https://doi.org/10.25380/iastate.19111376>

The code for data analysis can be found at: <https://doi.org/10.5281/zenodo.5980943>

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